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ABSTRACT

This study investigated the relationship of several affective variables as predictors of academic performance in mathematics. The predictor variables studied were: (1) attitude toward success in mathematics; (2) confidence in learning mathematics; (3) perceptions of teacher attitude; (4) mathematics anxiety; and (5) locus of control. The sample of students studied were from a population who were denied regular admission to a large southern state university because they did not meet minimum admission standards. The students were conditionally admitted and enrolled in a developmental algebra course. The high school grade point average and the Scholastic Aptitude Test-Quantitative score were also used as predictors in order to provide a standard by which to compare the predictive efficiency of the affective variables. The dependent variable was the student's course grade in the first quarter. Results indicated that of the affective variables, a new variable created by averaging the level of confidence score and the mathematics anxiety score was the best predictor of mathematics performance. (Author/TW)

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Factors Affecting Mathematics Achievement in High Risk College Students

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ABSTRACT

This study investigated the relationship of several affective variables as predictors of academic performance in mathematics. The predictor variables were attitude toward success in mathematics, confidence in learning mathematics, perceptions of teacher attitude, mathematics anxiety, and locus of control. In addition, the high school grade point average and Scholastic Aptitude Test-Quantitative score were employed as predictors in order to provide a standard by which to compare the predictive efficiency of the affective variables. The dependent variable was course grade in the first quarter of mathematics. Of the affective variables, a new variable created by averaging the level of confidence score and the mathematics anxiety score was the best predictor of mathematics performance.

In recent years mathematics educators and researchers increasingly have expressed an interest in the relationship between affective variables and achievement in mathematics. Reyes (1984, p.558) defines affective variables as "students' feelings about mathematics, aspects of the classroom, or about themselves as learners of mathematics." Among affective variables identified in the literature for study in relation to mathematics achievement are factors such as student's attitude toward success in mathematics, confidence in learning mathematics, mathematics anxiety, effectance motivation, and mathematics usefulness (Aiken, 1970a, 1970b, 1976; Butler, M. & Austin-Martin, G., 1981; Fennema, E. & Sherman, J., 1976a, 1976b, 1977, 1978; Fox, L.H., Fennema, E., & Sherman, J., 1977; Richardson & Suinn, 1972). The stereotype of mathematics as a male domain has been identified as a factor which may influence the attitudes of females toward learning mathematics (Tobias, 1978). Additional mediating variables include

teacher attitudes toward mathematics, parental attitudes toward mathematics and toward their children as learners of mathematics, and peer attitudes (Aiken, 1970; Fennema & Sherman, 1976, 1977). Other social factors, such as socioeconomic status (SES), have been examined in relation to mathematics achievement. Aiken, (1970) did not find the SES factor to play an important role. However, Reyes and Stanic (1985) concluded from their extensive literature review that a strong correlation exists between race, sex, and SES of students and their achievement in mathematics. Locus of control or causal attributions may also serve as mediating variables which affect achievement in mathematics (Shea, K.A. & Llabre, M.M., 1985; Wolleat, P., Pedro, J.D, Becker, A.D., & Fennema, E., 1980).

Fulkerson, Galassi, and Galassi (1984) scrutinized the cognitions of high and low mathematics anxious college undergraduates for sex and anxiety related differences. No differences in performance on a series of mathematics problems were found. In another study the results indicated that "after controlling for mathematics aptitude, the construct of mathematics anxiety does not significantly improve the prediction of grades in a beginning college algebra course for

either men or women" (Llabre and Suarez, 1985, p.285). Similar results were reported by Resnick, Viehe, and Segal (1982) and Dew, Galassi, and Galassi (1984). Siegel, Galassi, and Ware (1985) found that mathematics anxiety was not as successful as a predictor of performance on the final examination of an introductory college mathematics course as were other variables, specifically incentives and self-efficacy.

Gourgey (1984) asserts that self-assessments made by mathematics anxious students are not necessarily realistic indicators of ability, yet these students perpetuate their low self-concepts by failing to recognize their mathematical accomplishments. Hackett (1985) determined that mathematics self-efficacy, as influenced by sex role socialization, amount of mathematics preparation, and thus mathematics achievement, is predictive of both mathematics anxiety and choice of college major. Several studies reported significant negative relationships between mathematics achievement and both previous number of mathematics courses taken and mathematics anxiety (Austin-Martin, Waddell & Kincaid, 1980; Buckley & Ribordy, 1982; and Alexander & Cobb, 1984). Wright and Miller (1981) found a lower mean on the MARS (Mathematics Anxiety

Rating Scale) for the developmental mathematics subgroup than for students enrolled in the basic college algebra courses. In other studies, no significant differences were reported in locus of control between developmental students and other freshmen (Cartlege & Walls, 1985) nor between locus of control and mathematics achievement (Biaggio & Pelofski, 1984). No significant gender differences in locus of control were reported by Cartlege and Walls or by Blustein and Lester (1979).

It would appear that there are a number of inconsistencies in the findings pertaining to affective variables and gender, as related to mathematics performance and/or achievement of college students. This study examined attitudinal variables (mathematics anxiety, confidence in learning mathematics, attitude toward success, perception of teacher's attitude toward one as a learner of mathematics) and locus of control as predictors for both male and female first quarter developmental studies mathematics students. High school grade point average (HSGPA) and scores on the quantitative subtest of the Scholastic Aptitude Test (SATQ) were also included in order to provide a basis for comparing predictive efficiency.

Method

Sample

The sample consisted of 118 students out of 243 who matriculated in the Division of Developmental Studies at a large southern state university (enrollment over 20,000 students) during the fall quarter of the 1985-1986 academic year. To be eligible for enrollment in Developmental Studies, students were denied regular admission because they did not meet minimum admission standards. The 118 students were those who enrolled in developmental algebra courses and who completed all of the instruments used in the study. Instruments were administered to students within the first two weeks of classes. The sample included 59 males and 59 females, of whom 96 were Caucasians and 22 minority group members. For the total group the mean HSGPA was 2.58 and the mean score on the SATQ was 408.

Instruments

Four of the nine Mathematics Attitude Scales (Fennema & Sherman, 1976a) were administered--Confidence in Learning Mathematics, Mathematics Anxiety, Attitude Toward Success in Mathematics, and Students' Perception

of Teachers'Attitudes Toward Them as Learners of Mathematics. Each of the scales consisted of 12 items, half of which were positively worded and half were negatively worded. The items which were negatively worded were reversed for scoring. The item scores were added to obtain the overall scale score. A high score on the Mathematics Anxiety Scale indicated a low level of anxiety towards mathematics.

Locus of Control was measured by Rotter's Internal-External Scale (1966). The instrument consists of 29 forced choice items, including six items serving as fillers. Scores range from zero (highly internal) to 23 (highly external).

The first quarter course grade in mathematics (MGRADE), the SATQ score and the HSGPA were taken from student records.

Analyses

Multiple regression analyses (SAS, 1985) were run to access the contributions of the independent variables to the dependent variable of academic performance in the first quarter mathematics course. In an attempt to determine which variables contributed significant amounts of unique variance to the prediction of mathematics grade, stepwise regression

analyses were performed. All analyses were run on the total sample and separately for males and females.

Results

The means and standard deviations of the variables indicate significant differences at the .01 level between males and females for the SATQ and HSGPA (Table 1). Females had a higher HSGPA, whereas males had a higher score on the SATQ. For the total group, significant correlations were found between the attitude factors of mathematics anxiety and confidence in one's ability to learn mathematics and the first quarter mathematics grade, r=.37, $p<.01$ and r=.35, $p<.01$, respectively. An examination of the correlations also confirmed findings from Fennema and Sherman (1976a) concerning the relationship between mathematics anxiety and confidence in learning mathematics scales. The strong correlation, r=.85, suggests that the two scales measure the same concept. Therefore, for the regression analyses an average of the two variables was computed to produce a new variable, CAN, in order to determine any unique contribution to mathematics grade.

The results of the regression analyses indicated that the variable CAN was the only attitudinal variable significantly contributing to first quarter grade in mathematics. For the total group fourteen percent of the variance in the first quarter grade was attributed to the CAN factor (Table 2). Confidence/Anxiety and the academic variables of HSGPA and SATQ score accounted for 18 percent of the total variance in the MGRADE.

When the total sample was divided into two groups on the basis of gender, analyses indicated that CAN accounted for 12 percent of the total variance in first quarter mathematics grades for males and 16 percent of the total variance for females. The three variables of CAN, HSGPA, and SATQ accounted for 15 percent of the total variance in first quarter mathematics grades for males and 26 percent for females.

Discussion

Based on the relationship found between mathematics anxiety and performance in the first quarter of mathematics for students in this Developmental Studies program, it would appear that students in college programs would benefit from strategies designed to

reduce the level of anxiety toward mathematics. In addition, mathematics instructors and counselors might predict a close relationship between a student's confidence in being able to perform a mathematical task and the lack of anxiety felt when confronted with the task. The regression analysis in this study supported the importance of confidence and low anxiety to mathematics achievement. The confidence/anxiety factor contributed the most variance in predicting mathematics performance for the total group and for the male and female subgroups. Therefore, a strong implication of this study for both mathematics instructors and counselors is the need to focus on strategies which build confidence as well as those which reduce anxiety for high risk mathematics students.

Because few students in remedial mathematics classes have enjoyed previous success in mathematics, these students in particular can benefit by a less threatening mathematics Classroom environment and a commitment to excellence in teaching. An effective instructor in developmental mathematics must not limit the instructional process to concerns of cognition; it is imperative that instructors focus attention on both the affective and cognitive domains. The instructors

of Developmental Studies mathematics at this institution are available to provide considerable extra help outside the classroom. They frequently use individual tutoring and mathematics journals to teach study skills, analyze student progress, and understand the affective domain of students. A course required of all students in the Developmental Studies program which is taught by the counseling faculty assists student with goal setting (motivation), communication skills, study strategies, and anxiety reduction. Through techniques such as systematic desensitization and/or cognitive restructuring, students may develop a more positive attitude toward learning mathematics and thus reduce mathematics anxiety. Assertiveness skills are taught to assist students in learning to ask for extra help.

Comparing mean differences in males and females, this study found females to have higher HSGPAs whereas males had higher SATQ scores. It is interesting to note, however, that males and females were equally successful in their first quarter mathematics course. It appears likely that intervention strategies used by the mathematics instructors and counselors may assist students in overcoming their entry level deficiencies

in this content area. The strategies which are given to students in this university's Developmental Studies program may help mitigate motivational barriers for male students (as perhaps indicated by low HSGPA) and skill deficiencies in female students (as evidenced by low SATQ scores). Thus, individualized instruction provided by this program should be noted when comparing results of this study with findings concerning populations of students in other entry level university mathematics classes.

The findings of this study have implications for admission personnel as well as mathematics instructors and counselors. The SATQ score, which generally is perceived to be an excellent predictor of success, is perhaps less accurate when utilized in relation to high risk students. Further research focusing on developmental mathematics students is needed to confirm these findings. Meanwhile, high school grade point average may be a more significant factor in assessing aptitude and/or motivation for female students than for male students in developmental mathematics programs.

Discrepancies among previous studies regarding the relationship of affective variables to mathematics achievement may be explained by a closer examination of

the populations studied. For students participating in a developmental mathematics program, anxiety or lack of confidence in one's ability to learn mathematics may serve as a more viable predictor of success than such standard measures as SATQ scores and HSGPA.

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Table 1

Means and Standard Deviations of Variables

Variables	Females n = 59 M	SD	Males n = 59 M	SD	Total Group n = 118 M	SD
Attitude toward success (AS)	52.64	5.63	51.41	6.11	52.03	5.88
Teacher (T)	42.95	7.54	42.73	7.61	42.84	7.54
Mathematics anxiety (AN)	33.61	11.37	36.00	11.22	34.81	11.31
Level of confidence (C)	38.80	12.10	41.08	11.32	39.94	11.72
Locus of control (LC)	9.31	3.62	9.51	3.76	9.41	3.67
*High School GPA (HSGPA)	2.69	.43	2.47	.43	2.58	.44
*SAT Quantitative (SATQ)	382.37	62.73	433.56	62.80	407.97	67.58
Mathematics grade (MGRADE)	2.42	1.12	2.34	1.12	2.38	1.12

*Significant difference between males and females at .01 level.

Table 2

Multiple Regression Analyses of Mathematics Grade

Predictor	R^2	R^2	F^a	df_n	df_d	P	b-weight
			Total Group				
CAN	.1385	.1385	10.73	1	115	.0014	.0299
HSGPA	.1582	.0197	5.24	1	115	.0239	.5655
SATQ	.1804	.0222	3.09	1	114	.0814	.0029
Intercept= - 1.3638							
			Males				
CAN	.1242	.1242	4.93	1	57	.0306	.0311
SATQ	.1408	.0166	1.35	1	56	.2499	.0028
HSGPA	.1461	.0053	.34	1	55	.5631	.2040
Intercept= - .5748							
			Females				
CAN	.1633	.1633	5.95	1	57	.0180	.0294
HSGPA	.2110	.0478	6.89	1	56	.0112	.9538
SATQ	.2614	.0504	3.75	1	55	.0579	.0579
Intercept= - 3.0292							

[a]F-test is for the increase in R^2.
[b]Weights are derived wih all thee variables in the equation.